What does a long-term sustainable economy look like? (with lots of graphs)

I care deeply about meeting our energy needs with net-zero emissions. From what I can see it is an achievable goal, although how quickly we get there is an open question.

But let's assume we get to a net-zero or even zero emissions econonomy. What then? Everything I read tells me exponential economic growth is required in order to have a healthy economy.

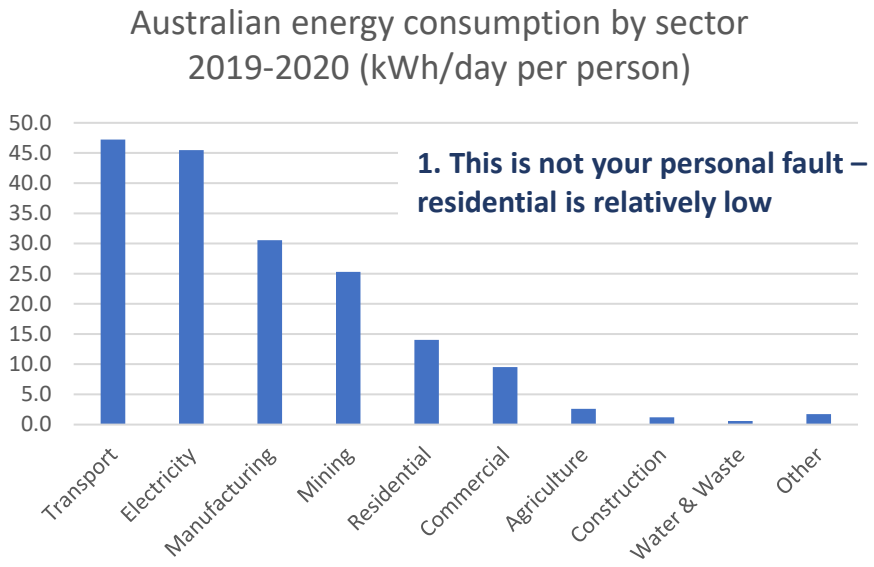
In the 1970's the limits to growth posited that exponential growth of an economy that consumes more resources as it grows cannot last for long in a world of finite resources.

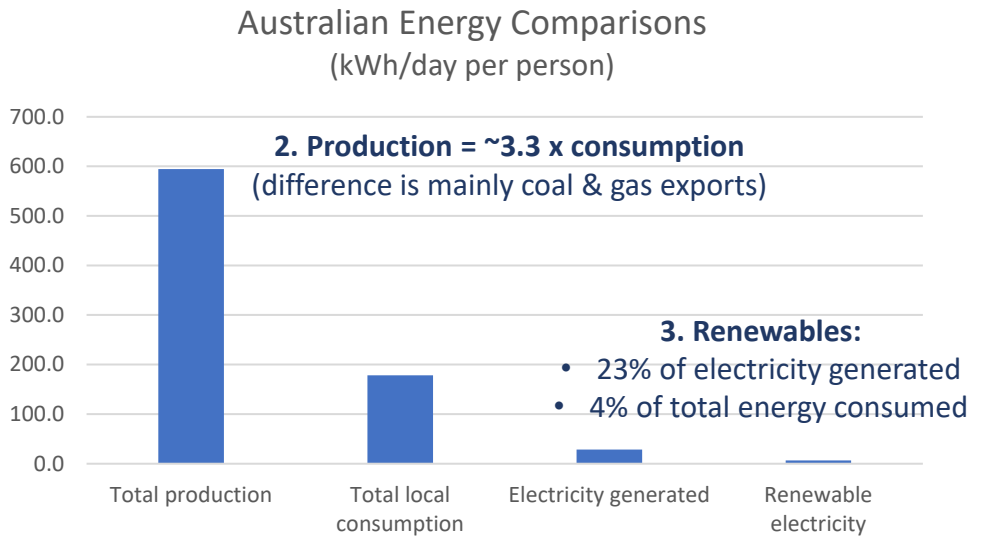
Is this still true? What is the relationship between our energy use and the perceived need for economic growth? What about our consumption of raw materials from the Earth? Are there alternatives to economic growth? This blog post will naively set out to investigate these questions.

Firstly, where are we now with energy and material use?

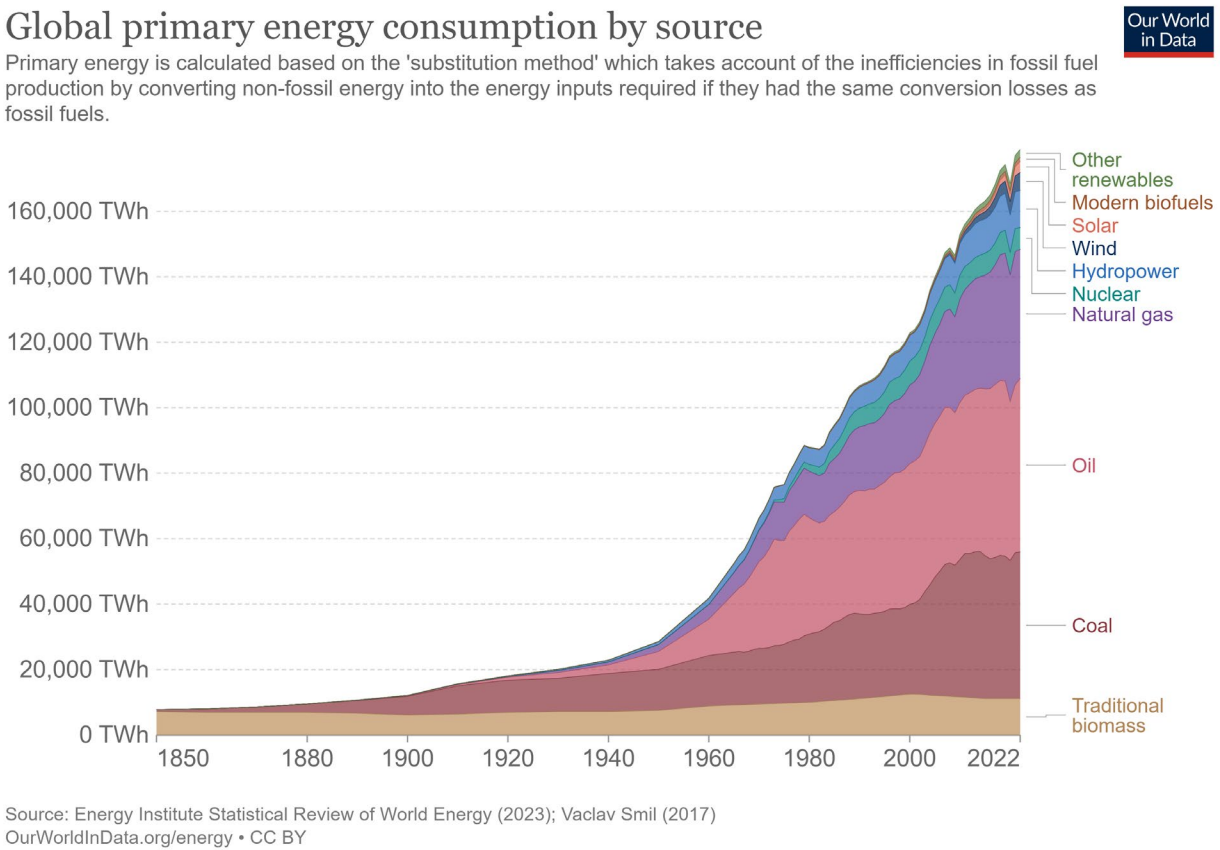
How much energy do we use in Australia?

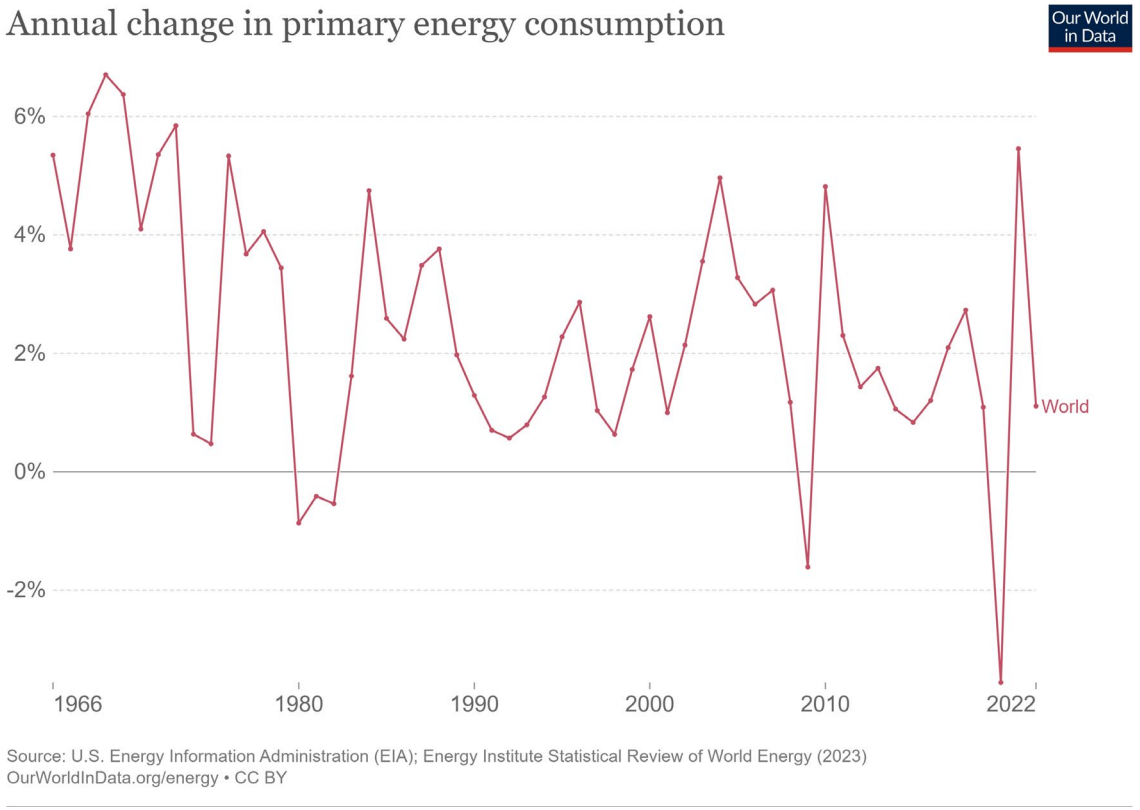
- Australia, 2020: Total local *consumption* = 1.7 TWh (6,014 PJ)
  - About 180 kWh/day per person
  - Human needs ~2500 kcal/day (~3 kWh)
  - So we use about 60x a human's basic needs per day per person in Australia
  - If we include *total production* (exports, conversion efficiencies etc), Australians use about 200 x our human requirements.
  - For comparison, EU is ~38x





Global change in energy consumption: it's still increasing 1-2% per year





https://ourworldindata.org/energy-production-consumption

Energy, Efficiency Gains and Economic Development: When Will Global Energy Demand Saturate?

Prepared by Christian Bogmans, Lama Kiyasseh, Akito Matsumoto

and Andrea Pescatori[1]

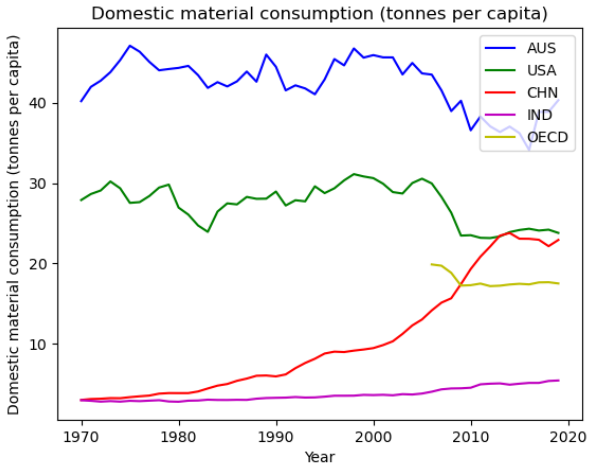
Authorized for distribution by Gian Maria Milesi Ferretti

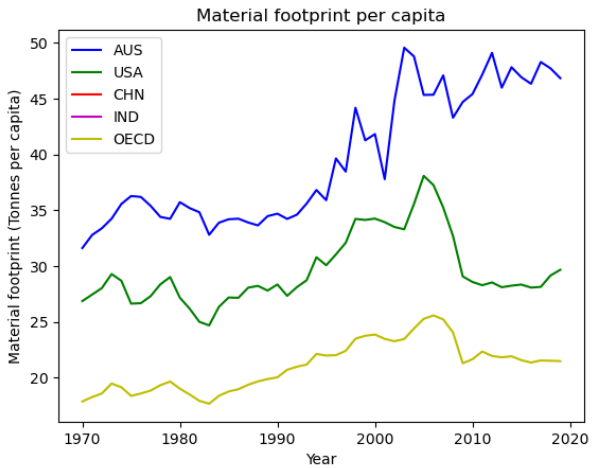
November 2020

Abstract

Not anytime soon. Using a novel dataset covering 127 countries and spanning two centuries, we find evidence for an energy Kuznets curve, with an initial decline of energy demand at low levels of per capita income followed by stages of acceleration and then saturation at high-income levels. Historical trends in energy efficiency have reduced energy demand, globally, by about 1.2 percent per year and have, thus, helped bring forward a plateau in energy demand for high income countries. At middle incomes energy and income move in lockstep. The decline in the manufacturing share of value added, globally, accounted for about 0.2 percentage points of the energy efficiency gains. At the country level, the decline (rise) of the manufacturing sector has reduced (increased) US (China) energy demand by 4.1 (10.7) percent between 1990 and 2017.

How much of Earth's materials do we consume?





Fix legend

There are several measures, but as this is such a broad look at the topic, I'll use 'material footprint', which reports the amount of material required across the entire global supply chain to produce goods and services that each nation demands.

data.oecd.org

From: https://www.oneplanetnetwork.org/sdg-12-hub/see-progress-on-sdg-12-by-target/122-natural-resources

"Domestic Material Consumption (DMC) and Material Footprint (MF) cover the two aspects of the economy, production and consumption. DMC reports the amount of materials that are directly used within a national economy. These include materials extracted in the country, plus those directly imported through trade of goods and services, minus those directly exported to other countries. **MF provides an additional perspective by taking into account materials required across the whole global supply chain to produce a good/service and attributing them to the final demand**. A country can, for instance have a very high DMC because it has a large primary production sector for export, while its final demand for materials might be relatively low. Conversely, a country may have a very low DMC because it has outsourced most of the material intensive industrial processes to other countries, while domestic consumers maintain a high level of demand for goods and services. MF corrects for both phenomena and ensures that material flows underpinning a country's consumption, but that largely take place in other countries' territories (and cause environmental impacts there), are attributed to the final consumers."

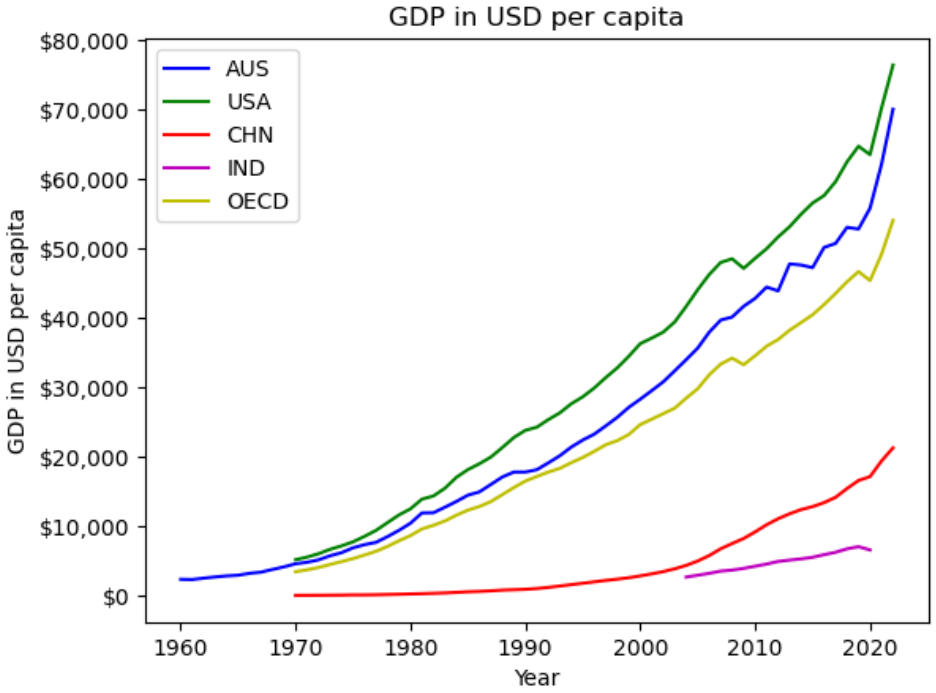
Mitigating these figures

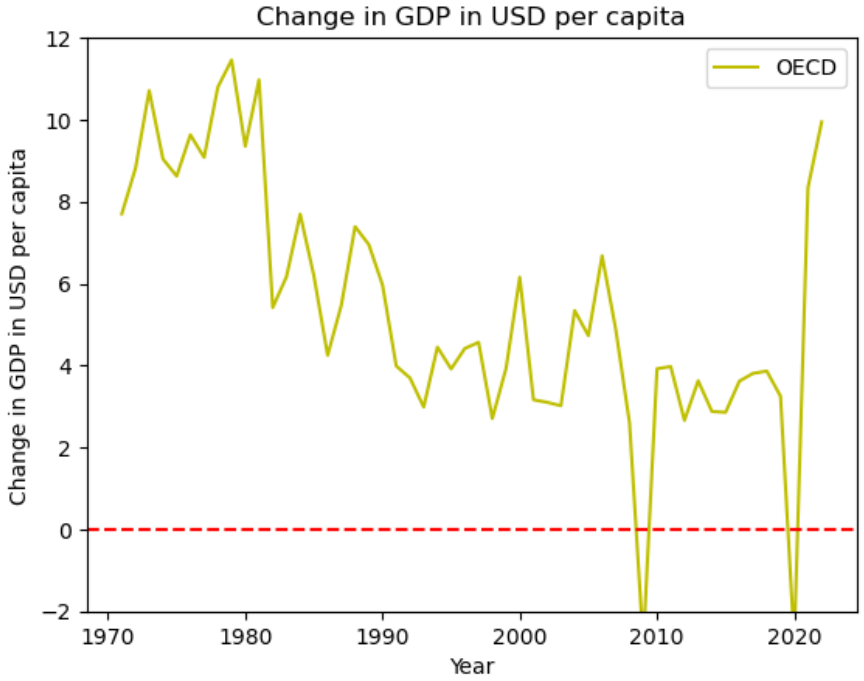
- Growing albeit fluctuating political, corporate, and financial momentum towards a “net zero” emissions future (dates vary)

- **Economic growth is taken as a given – but what relationship does it have with our environmental impacts?**

- **Does economic growth drive energy use and material consumption, or can they be ‘decoupled’?**

Economic growth





Date to 1960

What's the limit?

- Does energy demand continue to increase with **exponential** economic growth?
- **Even with 100% zero emissions, this is a problem:**
  - Land use for energy production and storage
  - Environmental and social issues from mining raw materials (*e.g*. lithium, cobalt, even sand)
  - Limits to availability of certain elements
  - Waste generated from end-of-life of PV, batteries, etc
  - Product consumption

We have three broad options

- Keep growing economy (GDP) whatever the cost to environment
- Decoupled growth aka “Green Growth” or “Sustainable Growth”
- Post-growth economy aka “de-growth” or “prosperous descent”

Keep growing

- “human ingenuity will eventually overcome all potential limitations to economic growth” (e.g. expansion into space, or vast increases in efficiency of material and energy use, carbon capture, recycling etc)
- Economic growth, and associated growth in tax revenue, employment and consumption, is a structural component of modern democracies and it is politically unfeasible to change this
- Politically seems to be a successful/popular approach

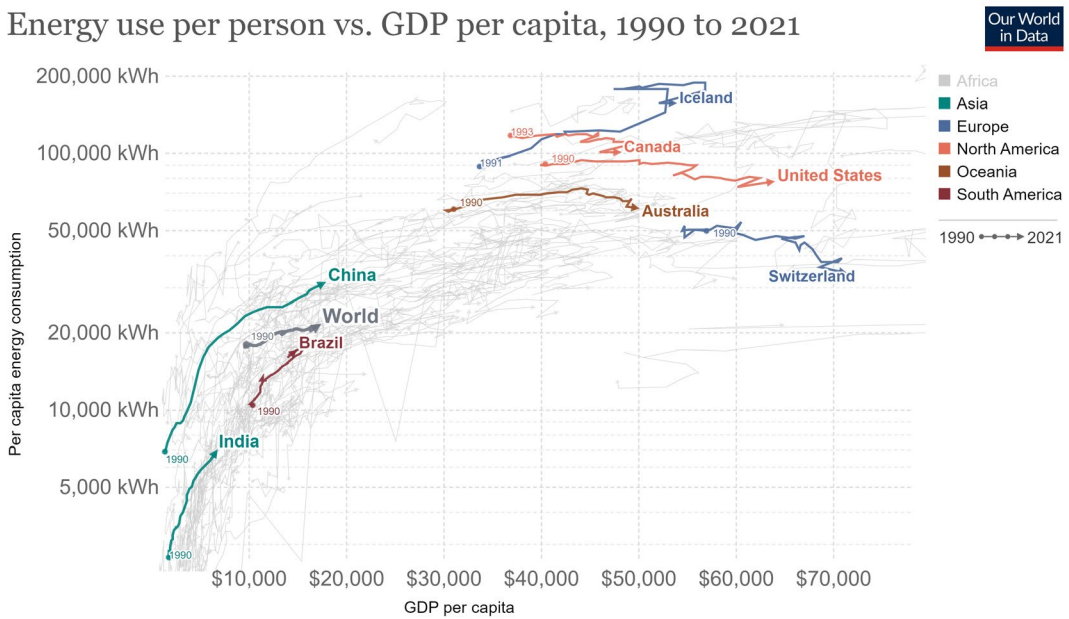
https://iopscience.iop.org/article/10.1088/1748-9326/ab842a

Decoupled growth aka “green growth” or “sustainable growth”

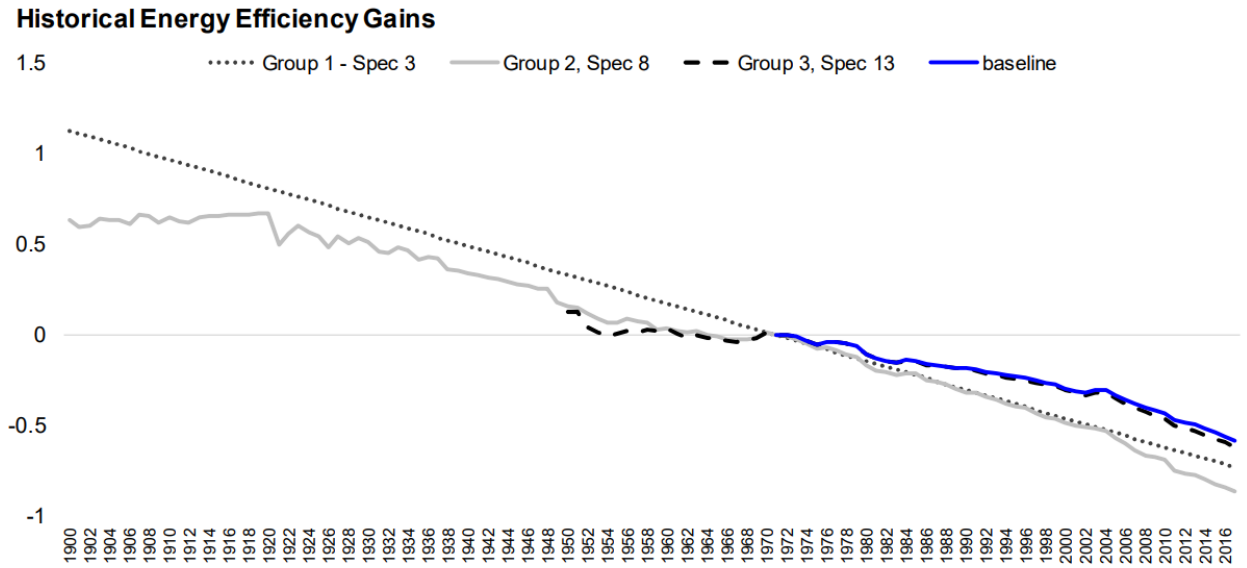
- “promoting economic growth while reducing the use of natural resources and GHG emissions. GDP growth coinciding with absolute reductions in emissions or resource use is denoted as 'absolute decoupling', as opposed to 'relative decoupling', where resource use or emissions increase less so than does GDP”
- Detailed legislative proposals e.g. Green New Deal, IRA
- Politically feasible e.g. AOC, Sanders

IMF Working Paper WP/20/253: “Energy, Efficiency Gains and Economic Development: When Will Global Energy Demand Saturate?” (2020)

“Kuznets curve”: implies that once nations develop to a certain GDP per capita, their energy use is either de-coupled from GDP growth – or shunted to developing nations.



Source: U.S. Energy Information Administration (EIA); Energy Institute Statistical Review of World Energy (2023); Data compiled from multiple sources by World Bank
Note: Energy refers to primary energy – the energy input before the transformation to forms of energy for end-use (such as electricity or petrol for transport).
OurWorldInData.org/energy • CC BY



Source: Energy Demand dataset, see Historical Data Appendix.
Note: The blue line represents the time dummies estimated in regression (4), Table 2. The dotted line is the time trend of specification 3, group 1; the light gray and dashed lines are time dummies of specification 8 and 13, see Table Historical Regressions. Series have been rebased to year 1971.

“Service economies” *can* de-couple from energy use…
…but someone else is still making things! (e.g. China)

Energy efficiency does improve over time…
… but there are hard physical limits...

Problem: global per capita energy consumption keeps going up with GDP per capita. No solid evidence that we can entirely decouple the whole globe's energy consumption from GDP growth.

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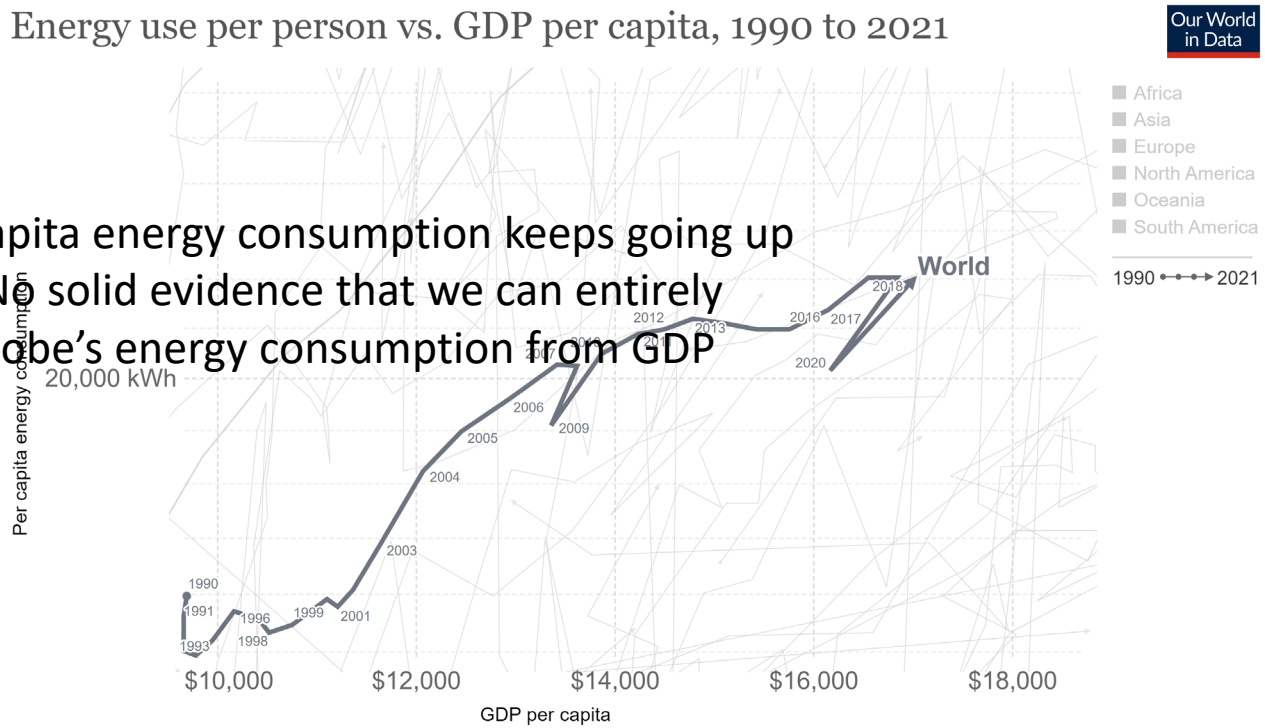

Source: U.S. Energy Information Administration (EIA); Energy Institute Statistical Review of World Energy (2023); Data compiled from multiple sources by World Bank
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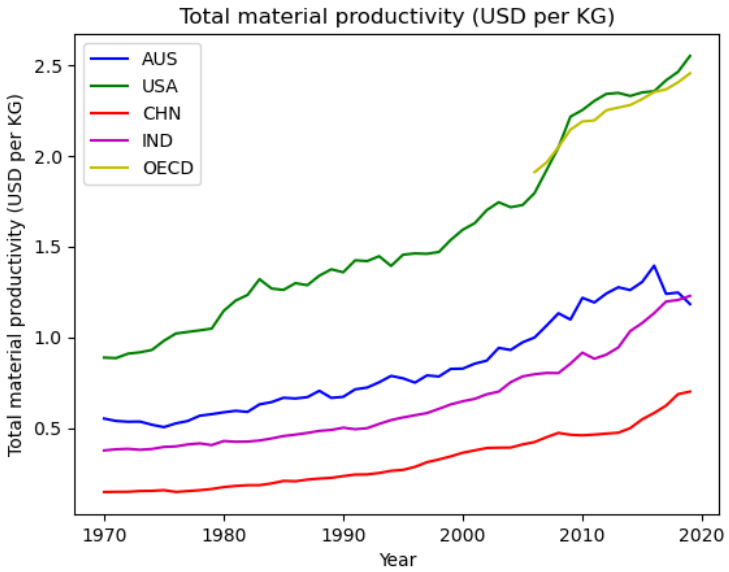
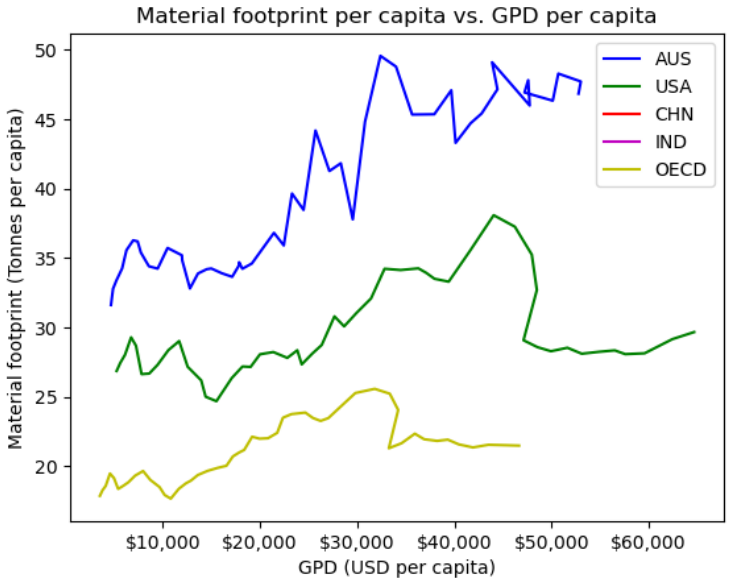
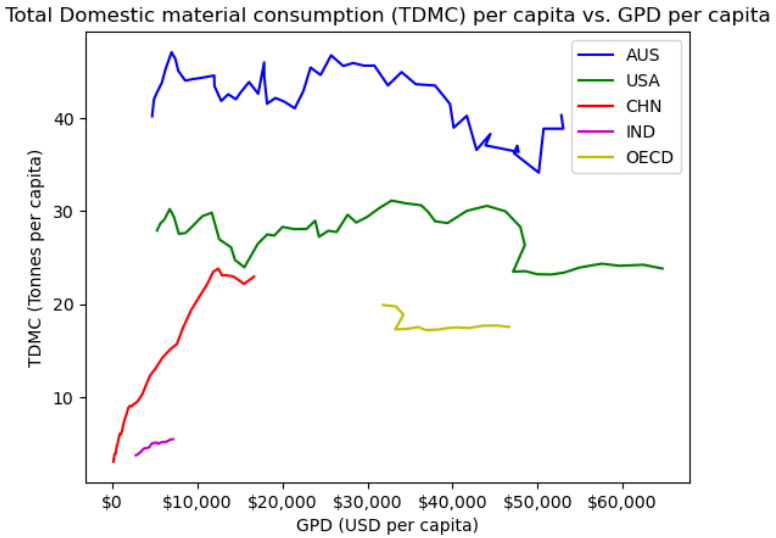
What about material use?



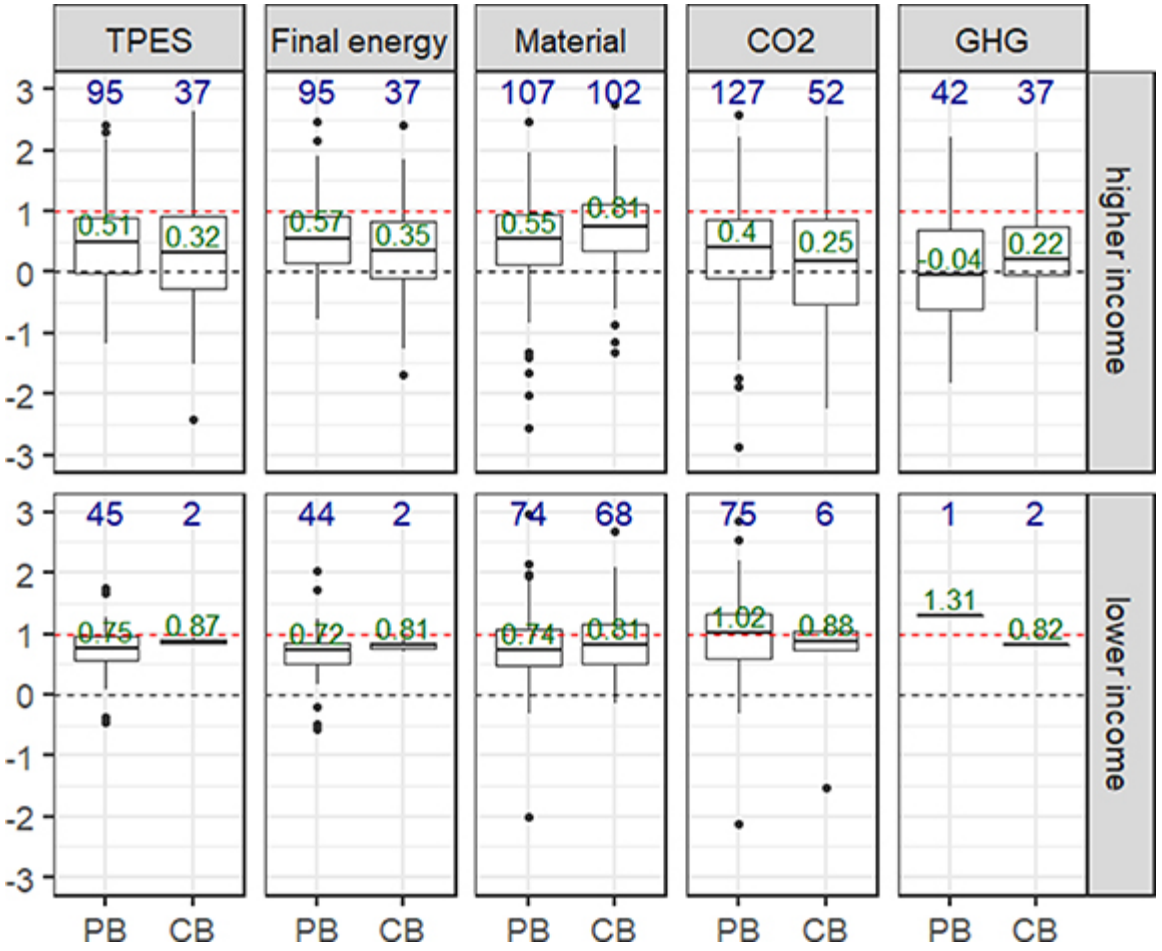




Material footprint or domestic material consumption figures, when plotted against GDP per capita, show a similar behaviour to a ‘kuyznets curve’. Again, there seems to be evidence that growth in material footprint is slightly de-coupling from GDP per capita, but not entirely, and less so for developing economies.

data.oecd.org

Issues



A median elasticity of CO_2 of 0.4 in the higher income class (top panels in figure 2) means that for 1% of GDP growth, production-based CO_2 emissions grew by 0.4%. Elasticities below zero indicate absolute decoupling and elasticities >1 that resources/emissions grew faster than GDP.

Even if rapid deployment of renewable energy could be achieved, however, the world's addiction to material resources would likely not wane, as harnessing renewables also requires substantial investments into large-scale buildings (e.g. hydropower plants), machinery (e.g. wind turbines, photovoltaic power plants) and infrastructures (e.g. expansion and reinforcement of electric transmission grids; Beylot *et al* 2019, Watari *et al* 2019).

Absolute GHG reduction goals can only be achieved if absolute goals for emission reductions are agreed upon

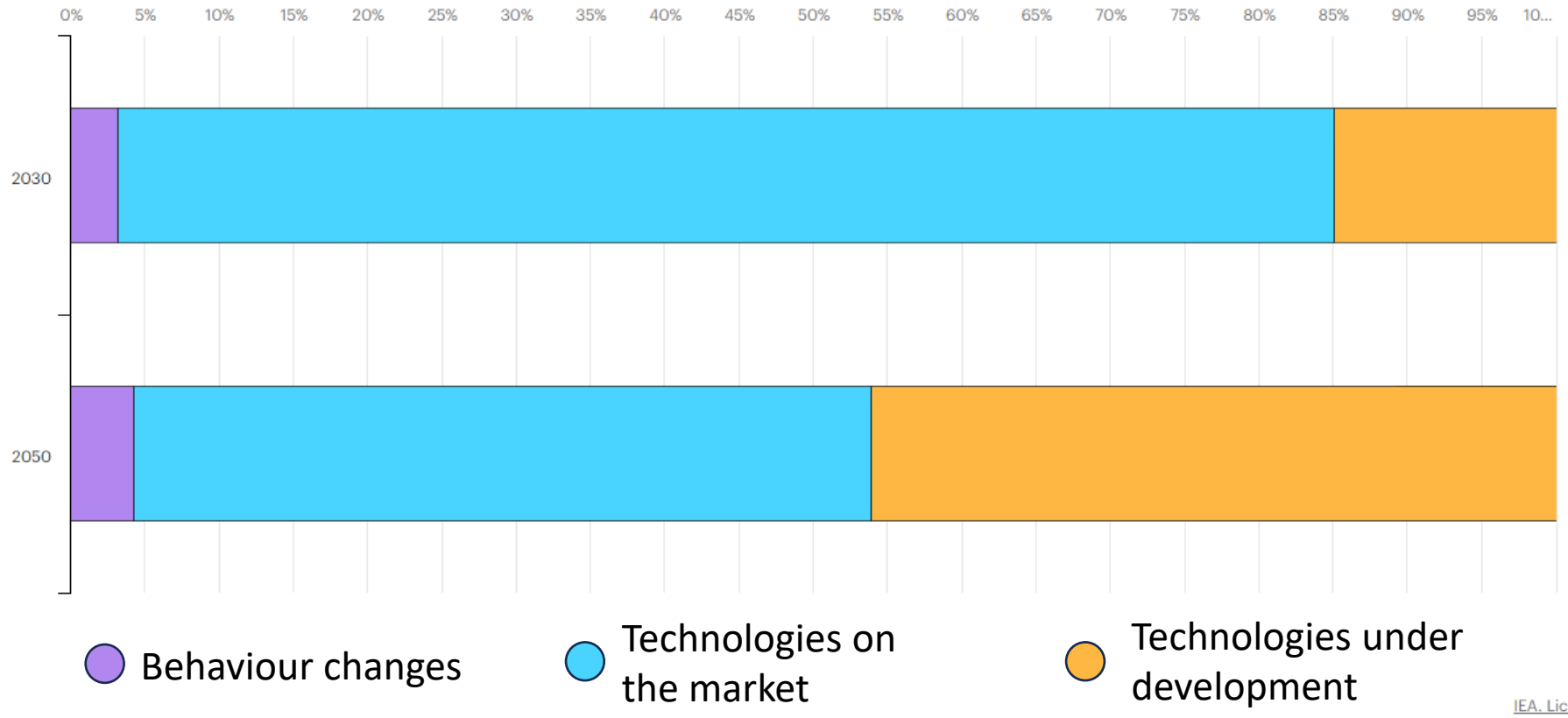
"We conclude that large rapid absolute reductions of resource use and GHG emissions cannot be achieved through observed decoupling rates, hence decoupling needs to be complemented by sufficiency-oriented strategies and strict enforcement of absolute reduction targets. More research is needed on interdependencies between wellbeing, resources and emissions." (https://iopscience.iop.org/article/10.1088/1748-9326/ab842a)

ctd

- Issues with decoupled growth:
  - Rising energy expenditure to extract resources
  - Rebound effects (EVs cost less per km -> people might drive more)
  - Problem shifting (e.g. PV -> new problem with solar waste)
  - Service economy requires material economy
  - Recycling is proving difficult and limited
  - **Tech is not meeting challenge fast enough and failing to address some areas (eg environment/ecosystem degradation)**
  - Cost shifting (externalisation of environmental impact from high to low income economies)

IEA: Annual CO2 emissions savings in the net zero-pathway: 2030 and 2050 relative to 2020

https://www.iea.org/reports/net-zero-by-2050



Post-growth economy (‘degrowth’)

“Circularity”

“Sufficiency”

Another recent strand of literature is focused on overcoming GDP as key target indicator of economic policy (Hoekstra 2019). This debate suggests that GDP may be becoming an increasingly irrelevant measure of welfare, as it was only loosely coupled with wellbeing in OECD countries over the last 40 years (Hoekstra 2019). In this view, GDP should be replaced or at least complemented by measures of wellbeing and planetary health, as suggested in the dashboard approach of the Sen-Stiglitz-Fitoussi-report (Stiglitz *et al* 2009), and in the Sustainable Development Goals. Scholars increasingly focus more on improving social wellbeing rather than GDP growth.

Studies in sustainable consumption increasingly argue that a decisive turn towards 'strong sustainable consumption governance' (Lorek and Fuchs 2013), that is, a clear focus on reducing the volume of the materials and energy resources consumed while maintaining levels of well-being, will be a key required for deep decarbonization.

https://www.theguardian.com/books/2021/may/06/post-growth-by-tim-jackson-review-life-after-capitalism

there is an urgent need to recalibrate our idea of work. Under capitalism, the function of labour is to generate short-term profits, trapping us in a perpetual present that redoubles our delusion of eternal life. Yet in a society that soberly acknowledges death, work would become a valuable means of “world-building” – forging cultural artefacts that endure after we’re gone, and connect us with future generations. Finally, Jackson asserts that his zero-growth utopia will be founded on activities that cultivate a sense of “flow”. Sports, crafts, social interaction and meditation: these sustainable practices satisfy the craving for transcendence by absorbing our attention, removing us from the quotidian and creating an experience of timelessness. They offer an image of eternity without emissions.

https://www.theguardian.com/books/2021/may/06/post-growth-by-tim-jackson-review-life-after-capitalism

- Since the publication of *Growth Without Prosperity*, a number of environmental theorists – including Robert Pollin, Leigh Phillips and Kenta Tsuda – have echoed the Treasury official, raising serious questions about the practicability of degrowth models. They have noted that if the transition away from fossil fuels threatens to cause a green recession, the sudden contraction of other economic sectors would likely lead to mass immiseration. A strong redistributive state would be required to prevent this outcome; but the state apparatus would itself be eroded under any eco-austerity regime. Can degrowthers prove the ecological benefits of their agenda justify the risk of plunging millions into poverty?

DG: In favour

- Robert Brenner ~ “low growth rates are the true cause of ecocide: in conditions of scarcity, corporations can only sustain their profit margins by turning to ever more damaging forms of extraction and pollution.” (https://www.theguardian.com/books/2021/may/06/post-growth-by-tim-jackson-review-life-after-capitalism)